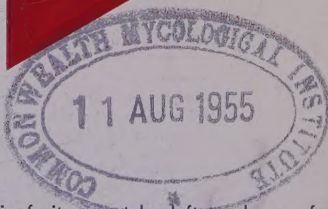
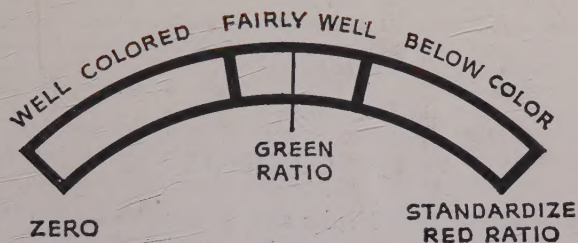


# BULLETIN

APRIL-MAY-JUNE, 1955



VOLUME XLIV, NUMBER 2

STATE OF CALIFORNIA  
DEPARTMENT OF AGRICULTURE

Color standardization for California fruit cannot be left to chance, for color measurement is a complex mixture of physics, physiology and psychology. Color charts, suggested by the forms above, have been used by department inspectors for many years; however an electronic measurement instrument rugged enough for field use has now been perfected. (See article by S. R. Whipple, page 47.)

STATE OF CALIFORNIA  
 GOODWIN J. KNIGHT, Governor  
 HAROLD J. POWERS, Lieutenant Governor

# QUARTERLY BULLETIN

Volume XLIV

Number 2

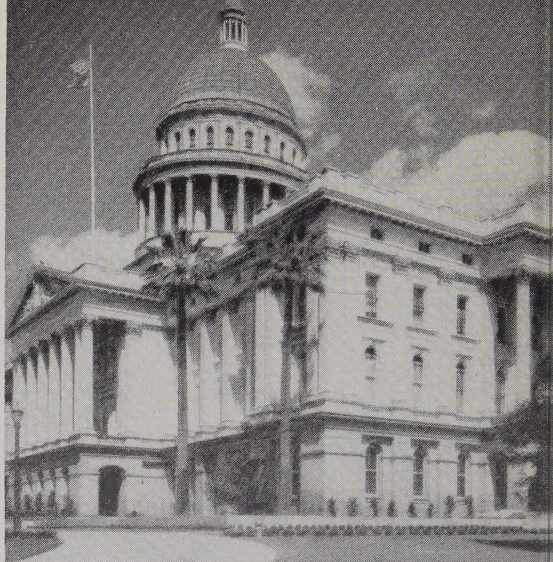
Official Journal of the Department of Agriculture, State of California

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The *Quarterly Bulletin*, published as a contribution to the welfare of California Agriculture, is mailed free to California citizens interested in the work of the Department of Agriculture. The *Bulletin* is exchanged, on request, for publications of the Federal Government, Experiment Stations, and other state or national agricultural offices or organizations.

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## COLOR INSPECTION—FRESH FRUITS AND VEGETABLES

By S. R. WHIPPLE

Assistant Chief, Bureau of Fruit and Vegetable Standardization,  
California Department of Agriculture

By legal specification in the California Agricultural Code, 13 commodities are required to meet a specific color requirement at the time of harvest (1). These commodities are strawberries, cherries, oranges, grapefruit, Elberta peaches, nectarines, Bartlett pears, persimmons, pomegranates, watermelons, apples, honey, and canning tomatoes. The purpose of these color standards is to prevent immature products from being sent into the channels of trade, and to provide a good reputation for California products in both our own State's markets and other markets throughout the Nation.

The first color standard pertained to oranges and was enacted into the law more than 30 years ago at the request of the citrus growers and shippers in California. The color standards for the other commodities also were enacted into law at the specific request of growers, packers, and processors whose products would be affected by the enforcement of the standard.

It should be noted that a number of other products, not regulated by the California Agricultural Code, are controlled by Federal or State Marketing Orders now in effect in California, which also have specific color requirements. We have been directly connected with one such color standard; namely, canning cling peaches. There are many applications of U. S. Grades in California which have color standards as part of the grade; however, these are permissive standards, and rejections under the police power of the state are not contemplated.

The color standards and methods described herein are for regulatory purposes; in other words, if the product fails to meet the standard, it must be rejected, and it is a violation of the state law for a producer to deliver, or a packer or canner to process, a load that fails to meet such standard.

Three of the newer methods of applying color standards have been selected for presentation here; namely, a plastic disc, a color photograph, and an electronic instrument.

It should be mentioned here that the California Department of Agriculture is not a research agency. Some of our inspection programs are large in scope, and we have found it necessary to develop a practical application so that sound research data available can be used.

### A PLASTIC COLOR DISC

If a single color is all that is needed and the surface of the fruit to be compared to such single color is homogeneous, and a visual comparison will suffice, then we believe a plastic disc of the proper color

EDITOR'S NOTE: Mr. Whipple's article was first presented to a symposium on color in foods—National Academy of Sciences—National Research Council.

is a method of depicting such a standard. This type of color standard was used in California during the past season for canning cling peaches. The color of the disc was established by mixing paints until we could put the paint on the peach flesh and it was evident there was a good visual match between the peach flesh and the paint. The matching was done under a controlled illuminant. Color discs were made from the paint, and were tested as a standard under field conditions during the 1951 and 1952 seasons (6). During the 1952 season, spectral reflectance curves were made of actual peach flesh that had been determined to be a close visual match to the painted disc. A plastics manufacturer<sup>a</sup> then made a plastic disc that was a good visual match to the painted disc, and the plastic disc also has a spectral reflectance curve which closely follows the reflectance curve of the peach flesh we were attempting to match as a color standard.<sup>b</sup> It should be noted that the coloring materials used in the plastic color disc are mineral, and are not subject to fading.

The purpose of the plastic disc was to provide a uniform standard of minimum maturity for fresh canning cling peaches, and it had to be established at a color level for the raw product, which would assure that the peaches, after they were canned, would meet the "Choice" color standard.<sup>c</sup> The University of California, Division of Food Technology, under controlled conditions, compared and canned many cases of peaches wherein the peaches, prior to canning, met the color standard we had established. This was necessary to determine whether the color of the finished product would meet the "Choice" color required. The tests were satisfactory, and the disc color was adopted by the industry as an enforcement standard for the 1953 season. Enough plastic discs were made so that all peach inspectors, as well as growers and cannery field men, were supplied.<sup>b d</sup>

#### A COLOR PHOTOGRAPH

If, however, the surface to be compared is nonhomogeneous, such as the cut surface of a canning tomato, then a solid color is not indicated. Again, if visual comparison to a standard is satisfactory, then a color photograph may be used. In the case of canning tomatoes, for several years we have used a color photograph as a standard for both the minimum for "well-colored," as well as the minimum for "fairly well-colored."<sup>d</sup>

It is important that the photograph standard be approximately the same size as the actual surface that is to be matched.

We made this type color standard by photographing the cut surface of a tomato which was relatively close to the standard; the laboratory<sup>e</sup>

<sup>a</sup> George Ingle, Research Department, Monsanto Chemical Company, Plastics Division, made up the sample plastic chips. Monsanto Chemical Company made the powder used for the final discs.

<sup>b</sup> Magnuson Engineers, San Jose, California, molded the final discs, and provided the technical color engineering necessary. They also had the spectral reflectance curves made for comparison.

<sup>c</sup> As applied to "Choice" grade for canning cling peaches in U. S. grades for processed products.

<sup>d</sup> Parties interested in securing samples of the plastic discs for grading peaches or sample prints for grading tomatoes should contact author through Department of Agriculture, State of California, 1220 N St., Sacramento 14, California.

<sup>e</sup> Atkinson Laboratories, Hollywood, California, made the final prints used.

which supplied the color photograph varied the color by using varying filters when running trial prints. These prints were then compared to the cut surface of actual tomatoes until the photograph with the exact color characteristics necessary was selected. The final prints were made at the laboratory by using exactly the same procedure as was used for making the particular sample photograph selected as correct. In addition, when the full order of final prints or photographs was received, each photograph was studied and compared under a controlled illuminant to a standard photograph; those which did not match were discarded.

#### APPLICATION OF COLOR STANDARDS

Industry representatives in California have always insisted that in making color determinations we use a method which, after our test has been applied, will permit the specimen tested to be handed to either the grower or the cannery field man so the outside appearance can be easily related back to picking operations. In other words, the grower and the cannery field man want something they can show the pickers to demonstrate from outside appearance what must be changed to improve the picking, and just as important, the processor wants to know what the color is like on the inside. It should be noted here that when inspecting canning tomatoes as a raw product, the relationship between outside color and inside color is frequently erratic.

Growers are anxious to harvest their fruits as soon as possible; for example, they want to avoid having fruit damaged either by excessive heat during the forepart of the season, or rain and possible frost in the latter part of the season. The processor is always confronted with the problem of color loss in processing, and is therefore concerned with having as many well-colored fruits in each load as possible. There are always various amounts of general defects, other than lack of color, in practically every load graded; therefore, the over-all percentage of defects in each load will be affected by the determination of how many fruits in each load fail to meet the minimum color standard. *Any variation*, by the inspector in his grading, from the established color standard will either adversely affect the grower if the variation is above the standard, or adversely affect the processor if the inspector's variation is below the standard (7).

Color determination and inspection by the human eye has limitations. Some of these limitations are: Conditions of natural illumination vary during the working day from early morning to late at night, and also vary from day to day as the season progresses. Artificial illumination, which might ordinarily be provided at grading stations, may not correct this situation. For the purpose of grading canning tomatoes, the State Department of Agriculture in California has equipped each canning tomato grading station with a uniform light source. It has a light temperature of 5500 to 6000 degrees Kelvin. The inspectors at some locations where daylight is not satisfactory keep the grading lamp on all the time; they are instructed to have the lamp on always after 4 p.m. each day, and always for grading prior to 9 a.m. We find a standard illuminant has improved our grading.

Another limitation occurs because the range of color of fruits and vegetables, as they are submitted to the inspectors for grading, is constantly changing, because the color is affected by the stage of maturity

at which the product is harvested. Our experience in inspection has been that if the percentage of well-colored fruits is generally high in the load, the grader apparently tends to raise his own color standard inadvertently; conversely, if the general color level of the load is low, the grader appears to lower his color grade. This variation is not an indication of incompetence on the part of the grader, but we do know that many people have poor color memory. The point is that the human eye can distinguish small color differences if there is available some standard for actual comparison.

At this point, we also must emphasize the importance of indoctrination training at the beginning of each season for both previously experienced inspectors, as well as others who may be newly-employed. In addition, we have weekly meetings which all inspectors must attend to keep themselves properly informed throughout the season.

In general, it also should be noted here that because the grower's interest in the load being graded, and the packer's or processor's interest in the same load may not always be the same, one or the other, or both, may inadvertently influence the inspector. For several years, we have established a set rule of regularly and frequently rotating inspectors from grading station to grading station throughout the season. We firmly believe this policy is important in attempting to maintain an impartial and uniform grade, and this applies to general defects as well as for color standards.

Summing up all the factors so far, it is our observation that we have not been able to consider our methods of color inspection completely objective, and that is our goal. Our experience points up the fact that it is difficult for any inspection agency to completely correct the fundamental problems associated with color determination made by the human eye. This opinion is also held by other investigators.

A more accurate and uniform method of color inspection requires an entirely objective method of color measurement.

#### AN ELECTRONIC METHOD

There are a number of instruments available which can be used to measure color characteristics of tomato pulp (2,4). Most mechanical or electronic machines require a specially trained operator, and some cannot be successfully operated except under standardized laboratory conditions. Also, they are designed primarily to measure the color of either the puree or juice of the finished product, or when the raw tomato is to be measured, it must first be crushed, strained, and extracted. In some instances, this unprocessed puree also is heated and deaerated.

The use of any particular instrument, in any particular system of grading, depends upon the *circumstances under which the grading is to be accomplished*, the *time*, and *personnel available*, and the *accuracy with which it is desired to measure the color*.

Our conditions in California require the grading of canning tomatoes to be done at canneries, and assembly stations where certain factors may affect the operation of an electrical instrument. Electrical current surges may be steep because of electrical equipment going on and off automatically; at assembly stations located a great distance away from the main electrical energy source voltage may be below normal. There will be considerable fog in coastal areas, heat in valley areas, and at



Figure 1. The Agron

times excessive dust and vibration. The elapsed time of an individual measurement must not add more than a few minutes to the present time required to grade a load of tomatoes. Present personnel available to our inspection service must be able, with few instructions, to operate the instrument accurately. The instrument must have a range sufficient to measure below and above the range of color we normally encounter in our inspection. In the case of canning tomatoes, the opposite halves will have different color characteristics, so the instrument must be able to measure the color of the cut surfaces of the two halves of the same tomato simultaneously, yet give only a single reading. This last point is important because, as mentioned before, California industry representatives always have insisted we use, for color determination, the visible area of the cut surfaces of both halves of the tomato being graded. It is understood that many different diameters of tomatoes must be measured, and these surfaces are not a homogeneous color.

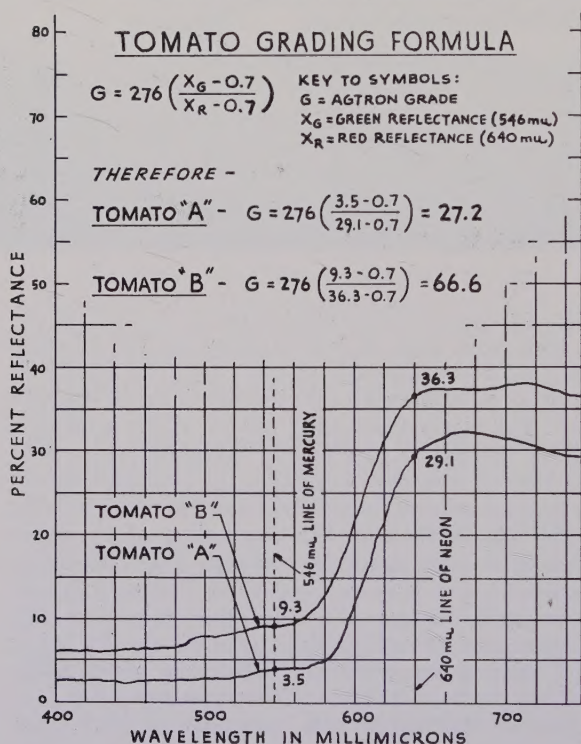
Industry representatives in California first proposed in 1949, that a study be made to determine if a machine could be developed that would measure the color of the cut surfaces of canning tomatoes objectively. This machine was to be developed by an engineering company with the help of the University of California, and was to be used for the purpose of assisting the canning tomato inspectors. Our participation was to test the instrument under actual field conditions.

Preliminary tests were conducted during the season of 1950, with an experimental model of a color-measuring machine. These tests served to prove the validity of the principle involved, and a number of changes in the design of the machine were suggested by these tests. In general, the principle involved is a variation of the "abridged spectrophotometer" (3). Production models were purchased, and further tests were

conducted during the 1951 and 1952 seasons. These tests were planned to try out mechanical operations of the machine under actual inspection conditions, as well as judge the machine's performance in measuring the color of tomatoes objectively at inspection stations. A large number of changes were suggested by these tests, and were incorporated in all machines prior to the 1953 season.

To operate the machine, which is called an Agtron (Figure 1), the inspector places the two halves of a cut tomato in the observation drawer and with the red circuit on, he sets the needle at a standard reference point; next he switches over to the green circuit, and wherever the needle comes to rest is the measurement recorded for that tomato (Figure 2).

The instrument takes a two-point measurement on the spectral reflectance curve of a tomato, and compares the red reflectance



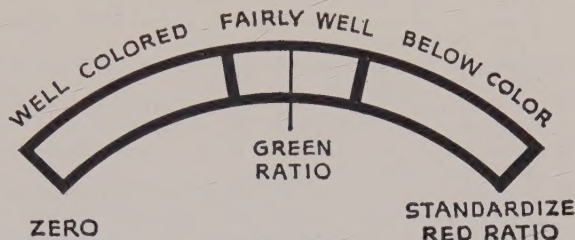
to the green reflectance (See accompanying table). The measurement, or reading, which is given is a function of the ratio between the two points measured (5). The zero position of the meter needle, in both the red circuit and the green circuit is checked occasionally by using black plastic discs in the viewing drawer; the instrument is standardized by using a standard plastic red disc in the viewing drawer. The standard red discs have the same characteristic spectral reflect-

ance curve as tomato flesh.<sup>†</sup> Identical discs are used in the machines at all grading stations. By this method all machines throughout the State are standardized. The idea of standardizing all machines by use of a standard plastic disc was first suggested by Miss Dorothy Nickerson, USDA, Cotton Branch. (The plastic color disc for canning peaches was also made possible by this suggestion.)

The 1953 season was the first season we were able to use the Agtron as a dependable instrument in grading operation, and it worked out very well, meeting all of our specifications. The inspectors were in-

<sup>†</sup> The discs, both black and red, were developed by the Monsanto Chemical Company, Plastics Division, in cooperation with Magnuson Engineers, San Jose, California.

Figure 2. Agtron dial face—when two halves of a cut tomato are placed in observation drawer and drawer closed, put lever in red position. By turning "Standardize" dial, needle is brought to rest at line labeled "Standardize Red Ratio." Lever is then moved to the left until it is in the green position; needle will come to rest in one of the three divisions on the above diagram. This reading indicates color grade of tomato being measured.



structed to use the Agtron several times daily to check their color grade. Most of the tomatoes in a sample box can be separated into the three colors required in California by observation; those which are doubtful are cut and compared to the photograph. If any question remains, the two halves can be put in the Agtron for a positive check.

#### IMPORTANCE OF A REPRESENTATIVE SAMPLE

An integral part of any system of color inspection is the validity of the sampling method used. The standard itself, or the method of using such a standard, is of little value unless the sampling procedure is as accurate a representation of the whole as possible (8). It is well established that the size of the sample must be in direct relation to the size of the load, the increase or decrease of the factor of grade being measured, the randomness that can be applied in selecting the sample from the load, and the expertness and reliability of the sampler. We have adopted a standard sampling procedure based on these principles. (See Appendix 1.)

The importance of these color standards, as they affect our color inspection in California, can best be evaluated if you know the amount of the products to which they are applied. Approximately 500,000 tons of canning cling peaches were inspected in 1953, and in the case of canning tomatoes, we inspect well over a million tons each year.

In closing, I would like to mention briefly two new color problems. The citrus industry, a few years back, started preliminary investigations with respect to the color of oranges at the time of picking, in relation to the color when sold in the fresh market. They accelerate the color process, but the finished product needs something more. We were asked to participate, and the studies are continuing to determine at what color the fruit must be picked to obtain a better color when marketed. The other point is in relation to canning tomatoes. Preliminary observation indicates that faster, more accurate color inspection can be had if we paint the surface of our canning tomato grading tables black. We tried this on four tables this season, and the results were good. However, we have yet to find a paint that will withstand the constant wear, and the effect of the tomato juice for a long enough time to be practical. The answer to these problems will have to be in the future.

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## ADDENDUM

*Sampling*

It is of utmost importance that you follow carefully the instructions for selecting the sample. If the sample you grade does not correctly represent the tomatoes in the load, the percentages on the inspection certificate will not be correct and this will unjustly penalize either the grower or the canner.

*1. Marking and Drawing Sample Boxes*

The State Department of Agriculture reserves the right to choose sample boxes from various parts of each load. Any difficulties that may arise in the pulling of these boxes from the load should be reported to the Group Senior. As a rule we do not take top boxes as part of our sample, and any exception to this rule can be authorized only by the District Inspector or Group Senior.

Designate the sample boxes with a chalk mark while the load is intact.

*2. Selection of Sample Boxes*

Approximately one-half of the boxes comprising the sample shall be taken from the inside tiers. In three, five, or seven box samples, at least one, two, and three boxes, respectively, shall be from the inside of the load. In four, six, and eight box samples, at least two, three, and four boxes, respectively, shall be from the inside of the load.

Outside boxes shall be taken from different rows and different depths with one box at least five deep if stacked seven or more high or next to bottom box if less than seven high.

Inside boxes shall be taken from different tiers and different rows with at least one box three layers deep in all samples and two boxes three layers deep on the eight box samples.

Note: Row means the line of stacks of boxes across the load. Tier means the line of stacks of boxes lengthwise of the load.

*3. Positive Check on the Number of Sample Boxes Graded*

Occasionally there is a question as to the number of sample boxes that have been graded. This is most likely to occur when two loads are being graded, at different grading tables, but on the same platform. The grading should start when the first box is taken from the load. However, to have a positive check on the number of boxes in the sample, no sample boxes are to be put back on the load until all of the

boxes in the sample (graded or to be graded), are at the inspection table.

#### 4. *Official Sample*

Canning tomatoes in any delivery shall be determined to be suitable or unsuitable for canning purposes as defined in Section 762 of the Agricultural Code by the examination of all of the tomatoes in a representative sample taken as follows:

Loads from	1 to 50 boxes, 2 box sample
	51 to 100 boxes, 3 box sample
	101 to 300 boxes, 4 box sample
	301 to 400 boxes, 5 box sample
	401 to 600 boxes, 6 box sample
	601 to 800 boxes, 7 box sample
	801 and up boxes, 8 box sample

The status of any load of canning tomatoes shall be determined by the inspection of the tomatoes in the representative sample defined herein except that when the resulting percentage of defects is only slightly more than that permitted by law and doubt exists as to the quality of the load; then an additional official sample consisting of the same number of boxes selected from different parts of the load may be selected. The weight of the defective tomatoes resulting from the inspection of the two representative samples taken shall be averaged to obtain the final percentage of defects for the load.



Figure 1. Road stand of  
Sicilian thistle, approxi-  
mately one acre, bordering  
Highway 50

**SULPHUR-COLORED  
SICILIAN THISTLE,  
*CENTAUREA SULPHUREA*  
WILLD.  
NEAR FOLSOM  
SACRAMENTO COUNTY**

MARGARET K. BELLUE  
Weed and Seed Botanist, California  
Department of Agriculture

Weeds have a way of spreading in a disorderly fashion, quite heedless of the efforts of botanists to classify them in an orderly fashion. It is the purpose of this article to reconsider Sicilian thistle in the light of a recent acceleration in spread and a reversal in classification. The normal rate of spread from the early established sites was given impetus by the earth-disturbing activity connected with the construction of Folsom Dam and the new Highway 50 route. That this starthistle should be classified as *C. sulphurea* Willd. was called to our attention by John Thomas Howell of the California Academy of Sciences. It is referred to as *C. sicula* L. by California authors.

**EARLY COLLECTIONS**

In the spring of 1923 while making a survey to determine the extent of yellow starthistle, *C. solstitialis* L., for the purpose of evaluating feasibility of proposed control procedures, W. C. Jacobsen discovered a new and much larger *Centaurea* below the old Folsom Road near Nimbus. As *C. sulphurea* Willd., its occurrence in North America was first published in a note by Mr. Jacobsen and Ethelbert Johnson in the Monthly Bulletin, California Department of Agriculture, December, 1923, Vol. XII, Nos. 7-12, 352. Under date of March 30, 1955, Mr. Johnson supplied us with the following information: "The specimen which I received from Mr. Jacobsen is in the C. F. Baker Herbarium of Pomona College, No. 17855. It bears the legend: '*Centaurea sulphurea* Willd.' IMJ '23—Loc. Folsom, Sacramento Valley—Date July 1, 1923—Coll. W. C. Jacobsen'. Ivan Johnson at that time was at Harvard. \* \* \* Although De Candolle questions whether the two species are essentially different, the dark upright spines of *C. sulphurea* would serve to distinguish it strikingly from *C. sicula*, which is described as having pale spreading spines."

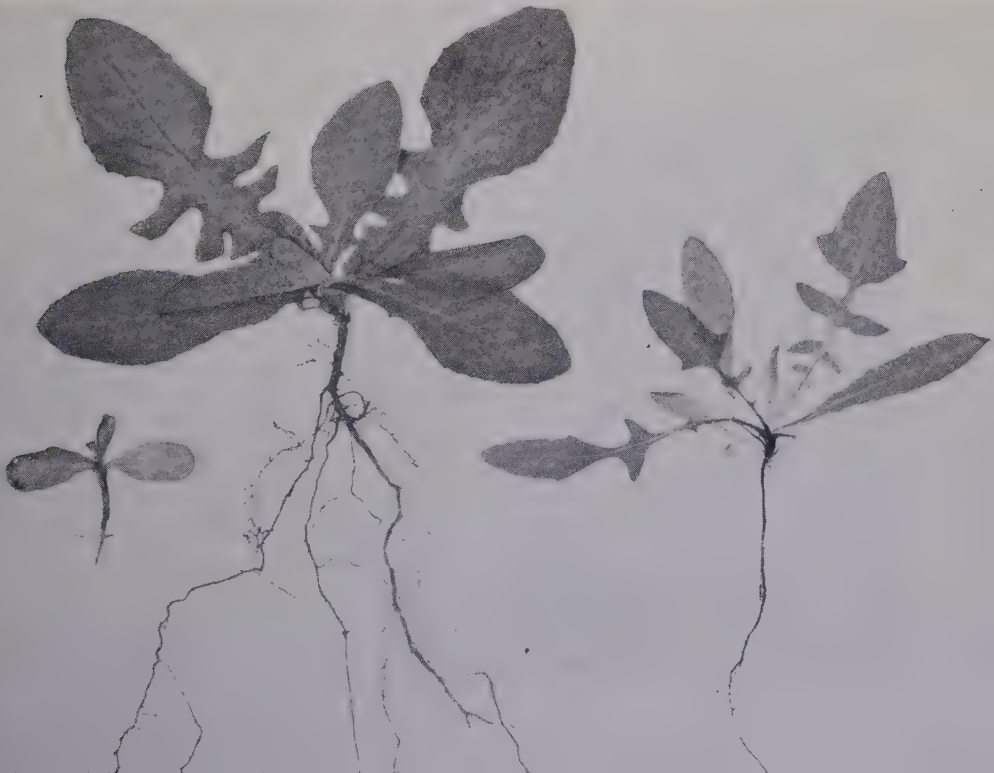
On May 24, 1923, the late P. B. Kennedy collected the same starthistle in Natoma, at the 18-mile sign from Sacramento. Plants from Dr. Kennedy's collection (now represented by specimens Herbarium Department of Agriculture, Sacramento, No. 1718 and Herbarium California Botany Department, University of California, Davis, No. 13444) were submitted to the Smithsonian Institution and to the Federal Seed Laboratory, Washington, D. C., where they were determined as *C. sicula* Linn., August, 1923.

## CURRENT STATUS

Recent surveys reveal more or less dense stands of *C. sulphurea* bordering the old Folsom Road from Nimbus to Alder Creek, with lateral spread toward the new Highway 50 route on one side and into fenced Aerojet General Corporation property on the other. Beyond the Southern Pacific tracks a vigorous extensive stand follows, for a considerable distance, the banks of an old built-up earth ditch. Above Alder Creek plants fringe both sides of the new Highway 50 for about six miles, fanning out over a large wedge-shaped area delineated on the west by the old road from Alder Creek through Natoma to Folsom, on the northeast by the Prairie City Road and on the south by Highway 50. (Figure 1)

Throughout this expanse of dredge tailings, *C. sulphurea* has become established where soil adequate to sustain more than the most depauperate forms of vegetation is available, as in the sediment on the bottom of dry dredge ponds and along the old roads which connected former dredge locations. The conditions obtaining in dredge tailings, discouraging to all types of vegetation, have conspired to limit the spread of this starthistle, which is an annual species introduced from the Mediterranean region. In some of the old pastures, as at the Folsom end of the Prairie City Road where *C. sulphurea* is found in association with our common *C. solstitialis*, the early germination and broad-leaved winter rosette of the Sicilian starthistle tends to crowd out the yellow starthistle. (Figure 2)

Figure 2. *Centaurea sulphurea* (actual size)



The 1952 and 1953 seasons were favorable for the growth of *C. sulphurea*, and an abundance of seed of high viability was also matured during the summer of 1954. The seed germinates with the early winter rains, and heavy stands of vigorous seedlings result, dense enough to crowd out all other growth on favorable open sites. During February of this year the writer counted the seedling plants on several one-foot-square plots and found a total of over 100 plants to the plot. Unless stands of this density become thinned, the competition produces spindly plants six to ten inches tall with single strict stems terminated by a single flower head. Where the stand is more open, *C. sulphurea* plants may attain a height up to four feet with a lateral spread of almost three feet, the numerous divaricate branches each terminated by a single large showy dark-spined sulphur-yellow flower head—quite a spectacular weed! (Figure 3) The bracts of the involucre are tipped by a slender rigid central spine, about 1 cm. long with three or four short spines on each side of the central spine. The spines are very dark at the base becoming pale toward the tip. As the flower head matures the spines become divergent and ultimately are completely deflexed on the old heads. Except for shedding of the corollas and most of the matured achenes, many heads remain intact on the plants through winter and into spring. The involucrel bracts darken to a charcoal black making this starthistle a conspicuous plant throughout the year. The dark shiny achene, about 6 mm. long, is topped by pappus of very dark antrorsely-barbed bristles of various lengths up to about 8 mm. (Figure 3, inset)

Spread of *C. sulphurea* to the northeast onto the marginal range lands bordering Highway 50 currently is effectively retarded by a 10-foot disced fireguard maintained between the highway and the Aerojet Company property. Toward the west, the dredge tailings are not conducive to rapid spread of this starthistle or any form of plant life.

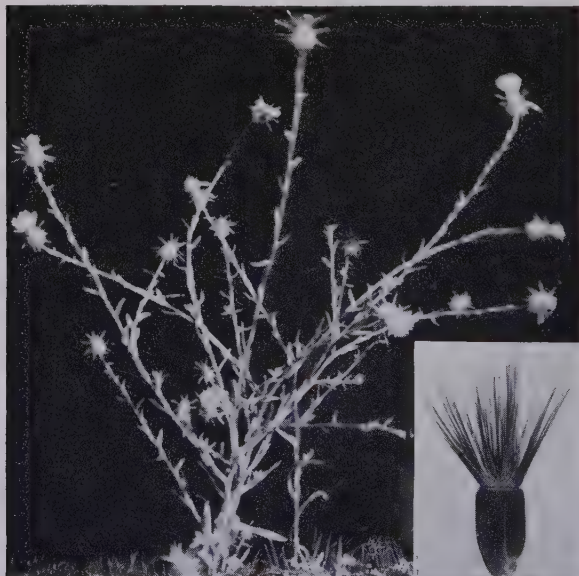


Figure 3. *Centaurea sulphurea*

Despite adverse conditions into which this annual from the Mediterranean was first introduced, it has gradually extended its range. What would *C. sulphurea* do beyond the buffer of unfavorable conditions by which it is now surrounded?

\* \* \* \*

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## ALMOND SCAB

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Almond scab is a disease caused by a species of the fungus *Cladosporium* which, during the past few years, has caused economic loss in the almond orchards of certain areas in California. It affects the fruits, shoots, and leaves of the host, *Prunus amygdalus* Batsch. The chief damage from the disease appears to be premature defoliation of the trees.

Almond scab was first reported in California in 1924 by E. H. Smith (4), who at that time identified the causal agent as *Cladosporium carpophilum* Thum. This fungus has been reported as causing a scab disease on various other stone fruits (5). However, field observations suggest that the fungus on almond in California may be different.

### SYMPTOMS

The symptoms of almond scab on fruits, shoots and leaves of almond are similar to those described for peach scab (3) and pecan scab (1, 2) on these hosts.

*Leaves.* The first macroscopic evidence of infection appears on the lower surfaces of leaves as indistinct, somewhat circular discolored areas barely visible to the naked eye. These infected areas enlarge and often coalesce, sometimes reaching a diameter of 10 millimeters. The color of the lesions is at first greenish-yellow, later turns to yellowish-brown, and finally to brownish-black (Fig. 1). On the petioles and midribs the lesions are of the same color but more elongate. When the lesions first appear, they are evident only on the under surfaces of the leaves; later they are visible on the upper surfaces. In most cases infection does not induce death of the tissues before premature leaf fall; however, in leaves that remain on the tree until autumn, necrosis of infected areas is not uncommon. Premature defoliation resulting from leaf infection probably constitutes the most important economic phase of the disease. During observations of 1954, symptoms on leaves appeared after those on shoots and fruits. The first macroscopic evidence of the disease on leaves was seen June 18, which was over three months after the first evidence on shoots (March 2).

*Shoots.* The young tender shoots appear to be more susceptible to infection than older ones. The first macroscopic evidence of disease appears as barely visible water-soaked areas. The presence of the fungus in these incipient infections has been demonstrated by isolations. Later these areas turn greenish-yellow, then brown. They are circular to oblong in shape, and their margins show a distinct dark color resulting from the sporulation of the fungus (Fig. 2). During fall and early

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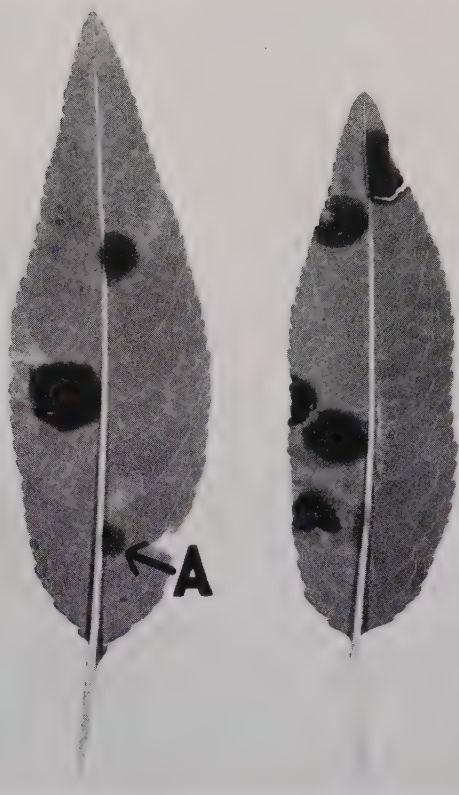


Figure 1. Severely affected leaves collected in the fall. (A) Young diffuse type lesion typical of those observed during the summer.

spring the typical lesions have a dark center surrounded by a light-colored ring and a blackish-brown area on the periphery. The fungus overwinters in these lesions and the following spring resumes growth on their margins, where sporulation occurs.

On January 15, 1954, some lesions of the previous year were examined for spores, but none could be detected. Re-examination on March 2 showed abundant sporulation on the advancing water-soaked margins of these lesions. At the same time minute, water-soaked incipient infections were macroscopically visible. Girdling of the shoots from this disease has never been observed and probably would not occur since lesions are very superficial.

*Fruits.* Indistinct, circular olivaceous areas represent the first macroscopic symptoms on the young fruits. These spots, at first quite small, enlarge by growth and may coalesce to form large, irregular, greyish-black areas often covering half or more of the fruit surface (Fig. 3). Infection appears to be principally restricted to the upper surface of the fruit as it hangs on the tree. Susceptibility of the nut hull, however, does not appear to be restricted to any specific area. Restriction in the normal growth of the epidermis occasionally results in the formation of shallow cracks in the hull. Fruit infection during 1954 was visible during early June. This occurred after visible shoot infection but before symptoms were observed on leaves.

## OCCURRENCE OF ALMOND SCAB IN CALIFORNIA

According to records of the Bureau of Plant Pathology, California Department of Agriculture, scab-infected almond specimens were received from Butte County during the years 1940, 1942, 1953, and 1954. Scab-infected almond trees were also found on the University of California campus, Yolo County, during 1942.<sup>1</sup> Examination of the University of California mycological herbarium showed collections of scabbed almond leaves from San Mateo County (collected April, 1950), Monterey County (July, 1942), and Napa County (September, 1946).

The results of a survey (1954) of almond orchards in Sacramento Valley show that almond scab is present in Butte, Colusa, Glenn, Sacramento, Sutter, Tehama, Yolo, and Yuba Counties but apparently not in Contra Costa or Solano Counties.

Other stone-fruit trees (apricots, cherries, nectarines, peaches, and plums) in or adjacent to scab-infected almond orchards have not shown scab symptoms. This raises the question as to whether the fungus on almond is the same as that reported on other stone fruits.

Almond scab symptoms have been observed on Drake, I. X. L., Jordanolo, Ne Plus Ultra, Nonpareil, Peerless, and a variety that the grower called "Smith I. X. L." They appear to be most severe on Ne Plus Ultra and the "Smith I. X. L." In some instances the trees

<sup>1</sup> Wilson, E. E., Personal communication, 1954.



Figure 2. Scab lesions on almond shoots. Enlarged portion (right) showing scab lesion (A) with dark margin caused by sporulation. Lesion at B caused by *Coryneum beijerinckii* Ould. (shot hole fungus)

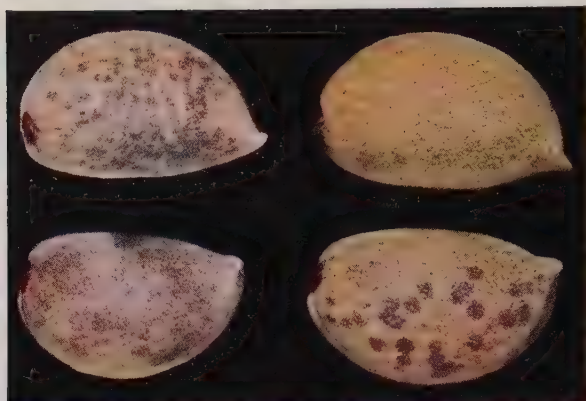


Figure 3. Three almond fruits showing various degrees of scab infection with one healthy fruit at upper right

of the Drake variety are severely infected. Symptoms on the Jordanolo variety are usually mild compared to those on other varieties in the same orchard.

The most severe scab infections usually occur in trees situated in lower areas of diseased orchards. The most severely infected orchards usually have a history of many irrigations per year, while many of the scab-free orchards are dry-land farmed or irrigated only one to three times per year. It appears from these observations that high humidity conditions are conducive to disease.

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## WALNUT BUNCH DISEASE

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Bunch disease is a systemic disease of walnuts caused by a virus. It was first described in 1932 by Waite (5) under the name "witches'-broom" and later by Hutchins and Wester (3) under the name "brooming disease," but "bunch disease" (4) is now the accepted term.

Bunch disease is widely distributed in the eastern United States. It has been reported from Alabama, Delaware, Georgia, Illinois, Indiana, Maryland, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and the District of Columbia. Additional states would probably be added to this list by more intensive surveys. Concern over possible spread of the disease to the West Coast resulted in California's placing a quarantine in 1949 on the importation of walnut nursery stock from east of the Rocky Mountains. The disease has not been reported outside of the United States.

In 1949 a walnut tree was reported near Yuba City, California, with symptoms somewhat similar to those on the diseased trees in the Eastern States. Since that time five additional trees similarly affected have been discovered on three more properties in an area approximately 100 miles long by 10 miles wide. Foliage on these trees appears normal in contrast to the chlorotic, narrowed leaflets on trees affected with the bunch disease. It has not been proven that the condition in California is due to the same cause.

Bunch disease occurs on eastern black walnut (*Juglans nigra* L.), butternut (*J. cinerea* L.), Japanese walnut (*J. ailantifolia* Carr.), Persian (English) walnut (*J. regia* L.), and possibly other *Juglans* species. There is considerable variation in the susceptibility of the various species of *Juglans*. Japanese walnut is most subject to attack, but the butternut is almost as susceptible. The Persian (English) walnut is less susceptible and eastern black walnut seems to be the most resistant. Often symptoms on this last species are so mild that diagnosis is difficult, and some trees may be symptomless carriers. The disease has been observed on trees of all sizes—from those in nursery rows to large mature trees.

Visible evidence of the disease varies. Symptoms include curling, cupping, chlorosis, and narrowing of leaflets. On many affected trees there are broomlike growths on the trunk and main branches (Fig. 1) formed by the continuing abnormal development of normally located axillary buds. Tightly packed bunches of small wiry shoots and undersized leaves result, hence the name bunch disease. The diseased shoots do not go into dormancy in late summer, but continue active growth. They are, therefore, very susceptible to cold injury and are usually killed back by the first hard winter freezes. Since even severely affected

trees sometimes exhibit normal growth early in the summer, these dead brooms serve as an early season indication that the trees are infected.

Another characteristic symptom of the bunch disease is upright, suckerlike shoots on primary and secondary branches and on the trunks



Figure 1. Bunch disease on Japanese walnut, showing the characteristic broomlike growths.  
Photo by Bartlett Tree Research Laboratories, Stamford, Connecticut.

of affected trees (Fig. 2). The terminal ends of branches often have a tufted appearance (Fig. 1).

The wood of diseased trees becomes very brittle, branches die back (Fig. 3), and often the tree is finally killed.

Sometimes on diseased trees the staminate catkins are malformed and flowering is abnormal (Fig. 4). Affected trees set few nuts, and those that mature are usually soft-shelled and poorly developed.

Young trees propagated from affected trees may grow for a considerable period without showing symptoms; therefore, detection of the disease in nursery trees is frequently impossible. There is some reason to believe that pruning hastens symptom expression. Gravatt

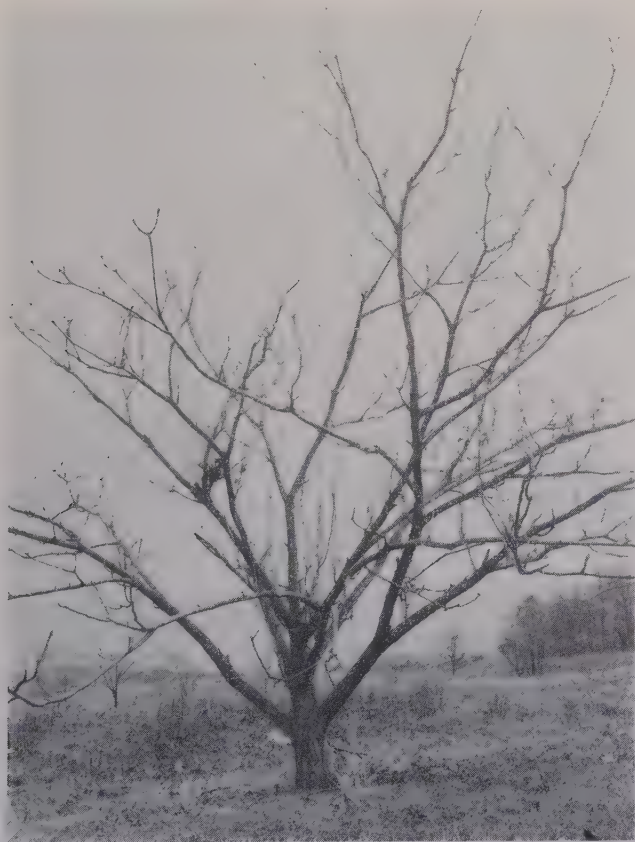


Figure 2. Bunch disease on black walnut with upright sucker growth typical of the trouble. This tree later appeared to recover from the disease.

and Stout (2) found that 37 percent of 300 apparently healthy black walnut seedlings in nursery rows developed symptoms of the bunch disease after being pruned severely. Only 4 percent of unpruned control trees showed the disease during the same period.

In 1944 and 1945 the disease was transmitted by patch-bark grafts by Hutchins and Wester (3). They found the incubation period to vary from several months to two years. It is not known whether the disease can be transmitted through seeds.



Figure 3. Bunch disease on Persian walnut, showing several characteristic broomlike growths and dying back of the branches. See arrows.



Figure 4. Abnormal flowering of affected Japanese walnut in September. Flowers usually appear in late May and early June. Catkins of the healthy Japanese walnut are similar to those of healthy Persian and black walnut.

Control of bunch disease is difficult because means of spread and method of infection are unknown. Preventing healthy trees from becoming infected is the best method of control. This can be done by cutting out and destroying all diseased trees of the host species with the possible exception of eastern black walnut. Removal of diseased branches from this species may be feasible, since it seems to show symptoms in fewer cases than the other walnut species and affected trees have been known to recover naturally. No infected trees should be allowed to remain in the vicinity of walnut nurseries. Even with this precaution, shipment of walnut nursery trees or scions from infected regions such as Eastern United States into the Western United States or to foreign countries should be prohibited.

Walnut orchards and plantings are numerous in the United States, especially in California where in 1953 there were approximately 137,000 acres (1) of Persian walnuts in orchards. These orchards represent a large investment. The destructiveness of bunch disease under some conditions causes real concern to walnut growers.

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## COOKING GARBAGE—ONE YEAR OF PROGRESS

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March 19, 1954, marked a turning point in over 20 years of unsuccessful efforts in California to control vesicular exanthema, a virus disease of swine. This disease first appeared in California in 1932 in swine fed raw garbage; but because it is clinically indistinguishable from foot and mouth disease, it was believed then to be that disease.

Efforts were made to control and eradicate the disease by slaughter and various types of quarantine and regulatory measures. It became obvious, after many unsuccessful attempts, that it would be impossible to control or eradicate the disease so long as pork scraps from swine having the disease were being fed back, in the raw stage, with garbage fed to swine. Unsuccessful attempts were made to pass legislation requiring the cooking of all garbage. California swine growers and related industries finally accepted the position that it would be necessary for them to learn to "live with" this disease.

It was not until June, 1952, that vesicular exanthema first appeared outside the boundaries of California, and in a matter of a few months, spread into 43 states and the District of Columbia; thus the disease became a national problem. California was placed under a federal quarantine which prohibited movement of both swine and unprocessed products leaving this State. This quarantine deprived purebred breeders, feeders and meat packers of an out-of-state market for their products. At the request of the various industries for relief, the Director of Agriculture made it possible to attempt control of the disease by using the regulatory and quarantine powers of the Director of Agriculture under provisions of a quarantine regulation which went into effect March 19, 1954. This regulation has resulted in outstanding and almost unbelievable accomplishment in the control of a livestock disease. In less than one year's time 552 or 97 percent of the ranches involving 218,893 or 97 percent of garbage fed swine in the State, have converted their operations from raw garbage to cooked garbage. This has been done at a cost of over \$1,000,000 to these hog feeders.

On March 19, 1954, there was little proven information available with respect to proper equipment and methods that would be necessary to cook garbage at a profit and in such a manner to be suitable as a good hog feed. Much courage and initiative have been shown by feeders throughout the State, by solving the many difficult problems involved in this new undertaking. It was believed, and so propounded by many for years, that garbage could not be economically cooked for swine, and that after cooking it swine would not eat it. All this has been proved untrue during the last year. Improvements are constantly being made in types of equipment used. Purpose of the following article, which details types and methods of garbage cooking, is to provide current information on these new improvements.

In addition to controlling vesicular exanthema, the sterilization of garbage fed to swine will result in the control of many other diseases, some of which are communicable to man. Many have expressed the belief that the nation-wide epizootic of vesicular exanthema, which has resulted in a nation-wide program of cooking garbage fed to swine, may have been a blessing in disguise should it develop that the disease known as hog cholera, which is likewise spread by feeding raw garbage, will be controlled. This disease costs the swine growers millions of dollars annually, and it is entirely possible that it can be completely eradicated after there is nation-wide cooking of all garbage used for swine feeding.

This outstanding accomplishment is the result of unusual cooperation—the combined efforts of the State-wide Vesicular Exanthema Committee, individual swine growers, meat packers, stockyards officials, farm organizations and federal, state and county regulatory workers.

Inasmuch as accomplishments, to date, have been principally the result of quarantine measures restricting movements of swine and swine products produced on raw garbage, the department feels it is imperative to protect the gains and financial investment by requiring under state law the cooking of garbage fed to swine.

A bill, passed by the 1955 California Legislature and approved by the Governor on May 23, will make it mandatory to cook garbage fed to swine on and after January 1, 1956.

## TYPES AND METHODS OF GARBAGE COOKING

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When the California quarantine regulation became effective, March 19, 1954, information on methods and equipment for the cooking of garbage to control vesicular exanthema of swine was rather limited. A single exception is the recently issued federal bulletin on the subject.

The conversion from raw garbage feeding to a cooking operation was not too difficult a problem to 400 small operators, but it did present an expensive investment for 200 of the larger operators.

This garbage cooking program was an entirely new experience for officials and field men of the Bureau of Livestock Disease Control, California Department of Agriculture, which was charged with administration and supervision of the program eventually expanded throughout the State.

Fortunately this was a cooperative program with the Animal Disease Eradication Branch of the Agricultural Research Service, United States Department of Agriculture. When a national emergency was declared, August, 1952, federal authorities requested mechanical and sanitary engineers in the United States Department of Agriculture be directed to investigate and develop types of equipment which would properly sterilize varying quantities of garbage. These men observed and studied existing garbage cooking operations in several states. As a result of their findings and technical ability, a bulletin on this subject, entitled "Equipment for the Heat-Treatment of Garbage to be Used for Hog Feed," was issued during February, 1954.

By request of the California Department of Agriculture federal authorities sent to California one of the engineers who had assisted in preparing the cooking equipment bulletin. This technician visited several ranches which were installing cooking equipment and addressed various groups of regulatory field personnel. His advice and counsel were of considerable aid in solving and preventing many cooking difficulties already apparent among operators who were trying to cook garbage properly.

The process of cooking varying amounts was not as simple an operation as generally believed. Although it is not a complicated procedure to cook small amounts over a direct flame, the required cooking of large amounts, over one ton, by steam methods produces many problems that have to be solved or corrected. The determination and ingenuity of some operators to cook at one time large quantities of garbage, 10 to 20 tons, was surprising.

There are several satisfactory types of steam boilers or generators on the market, but the question of the best method of steam cooking to fit the large operation is a serious and debatable matter. Any choice involves an investment of 5 to 40 thousand dollars, depending upon volume of garbage to be cooked. Thus, it is readily understandable why some operators have waited to check the results achieved by some of these new cooking installations, for their entire business enterprise was at stake.

#### TYPES OF COOKING EQUIPMENT

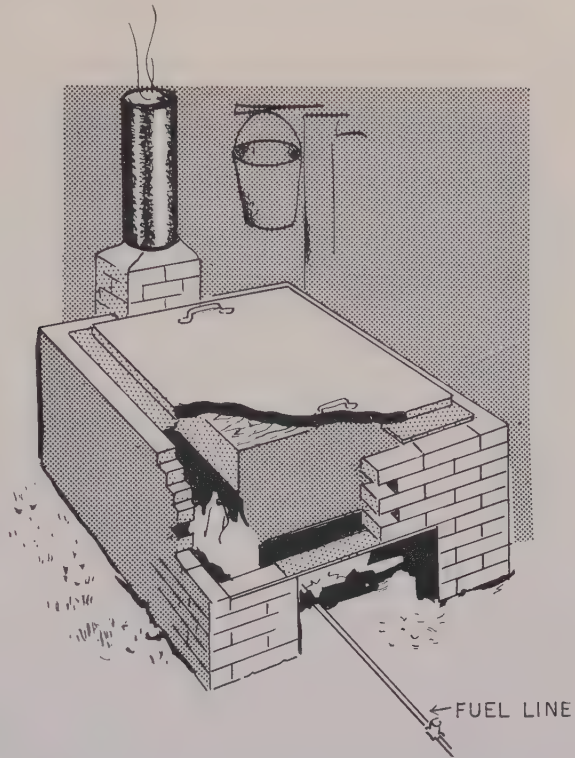
At the present time two methods of cooking garbage are used, namely, by direct fire and by steam. The injection of live steam, under pressure, directed into the garbage through numerous small outlets in steam pipes is the most efficient steam method. A boiling temperature throughout the mass, for a period of 30 minutes, is necessary to meet garbage cooking requirements and to insure destruction of the vesicular exanthema virus.

**Direct Fire Method.** Small operators, who feed up to a hundred head of hogs and who cook up to one ton of garbage at a time, generally use direct fire. Types of fuel which are used vary according to location of premises and may be wood, coal, crank case oil, fuel oil, tires and tank or natural gas. The site of the cooking operation should be protected from the elements and animals, and must comply with local fire or safety codes.

A firebox should be built of brick, stone or cement and lined with fire brick. The vat made out of a tank, barrel or other suitable material should be set into the fire box (not on top of it) in order that the direct fire may come in contact with the bottom, sides and ends and should be covered with a suitable lid. A chimney flue should also be constructed to provide necessary draft. Frequent stirring is required to prevent burning and to insure even cooking throughout. Temporary or slipshod installations are not satisfactory even for cooking small amounts of garbage.

**Steam Methods.** Steam methods are used wherever more than a ton of garbage must be cooked at one time. Steam boilers or generators must be of sufficient size to cook maximum loads which can be handled at one time. It generally requires eight horsepower of boiler capacity per ton of garbage. The steam injection method has proven the most

Figure 1. Construction for a direct fire cooker, used primarily by small operators who cook up to one ton of garbage at a time. Fuels used include wood, coal, crankcase oil, fuel oil, old automobile tires and tank or natural gas.



satisfactory. Closed steam systems or high pressure steam cookers tend to cause burning or caramelizing of the garbage, which is unpalatable for hog feed.

**Steam Pipes Installed in Truck Bed.** Many operators use the open injection method. Steam is injected into the load of garbage from pipes installed on the floor of the collection truck. This method is outlined in the United States Department of Agriculture Bulletin, previously mentioned. This booklet gives explicit and detailed instructions for installing cooking equipment, together with diagrams and pictures.

Where instructions and installations are strictly followed, proper cooking of truck loads of garbage can be accomplished in one to three hours; however, experience soon reveals that no two loads will cook in the same manner since the character of ingredients differs. Masses of materials such as bakery products, paper and vegetable greens resist heat penetration and form cold spots within a load. These areas cannot be properly cooked unless stirred up and then recooked for an additional period, to meet the specified requirements. Trying to stir by hand the cold spots in large loads of hot garbage is difficult and dangerous. Cold spots are located with a metal-stemmed dial-gauge thermometer which the operator or inspector inserts into all sections of the garbage load during or following the cooking period.

Operators in southern California overcame this problem by using a connection of steam hose with a metal extension, which is forced



Figure 2. Agitator type tank truck. This cooker can handle up to eight tons of food waste at one time in one hour, enough daily feed for 800 to 1,000 head of hogs.

down into the garbage mass where they find low temperatures. This method breaks up any material causing the cold spot and in a short time raises its heat to the required temperature.

At the start of the cooking program it was generally conceded that ordinary street garbage, containing considerable amounts of paper, could not be cooked properly. If such garbage was cooked, the paper and food materials blend into a homogeneous mass of little value as hog feed. This seemed to indicate the end of a business enterprise for some operators because in the past street garbage was dump-fed for hogs who rummaged through it for edible waste. City officials, however, cooperated with many of these operators by adopting ordinances requiring residents to sort household wastes. This procedure still allows considerable amounts of paper with which to be contended.

It was soon observed that without agitation satisfactory cooking of this type of "dry garbage" could not be accomplished. Large amounts of water must be added to the paper-wrapped garbage before the cooking period could be completed. Some operators installed sprinkling systems along the sides of the truck bed just under the metal cover, which has been satisfactory. The end result was a soupy mass which the hogs will readily eat; however, this type of cooked waste should be supplemented with grain or other vegetable products such as beans, peas, potatoes and rice to increase the food value. When these supplements are added to and cooked with the garbage, the product will tend to jell into a mass if allowed to stand overnight.

The lack of mechanical agitation and the length of time, fuel and labor involved to complete a satisfactory cooking job influenced many operators to install some type of an agitating steam cooker. There are two types of agitating steam cookers now in operation, either mobile or stationary tanks, which produce results to comply with cooking requirements.

**Agitator-type Tank Trucks.** This type of cooker on a truck chassis was developed, during the summer of 1954, by the pooling of ideas and the mechanical ingenuity of a few operators not satisfied with the steam pipe installations on the beds of their collection trucks. The first tank of this type was approximately 12 feet long, five feet in diameter, its long axis setting on a one and one-half ton truck chassis. The tank will cook up to eight tons of food waste at one time in one hour, enough daily feed for 800 to 1,000 head of hogs.

Steam is supplied by a 40-horsepower marine steam boiler and discharged under 50 pounds pressure. Steam header pipes, one and one-half inches in diameter, run along the lower outside of the tank. There are one-quarter inch steam jets, 14 inches apart, along each side and located at approximately five and seven o'clock positions, just inside the tank, pointing toward the bottom. The jets alternate along the bottom on each side at seven-inch intervals.

A hinged metal lid covers a three-by-six foot opening on the top of the tank and is lipped by angle irons which fit snugly into the opening. Two six-inch circular vents with pull out lids are also installed on top about two feet from each end. A three-inch shaft, about a foot below the center axis, runs through the length of the tank, upon which six metal paddles are intermittently attached. This agitator is chain driven from a power "take off" on the truck, being geared down to 12 revolutions per minute. A large outlet valve gate is located on the lower rear of the truck. The amount discharged from the tank is controlled by a small retaining bin with a slide-controlled gate, under which there is a swivelled feeding tube. This arrangement controls the amount of material being fed onto the feeding platforms; the swivelled tube facilitates feeding from either side of the truck.

A cement and steel ramp was constructed for the unloading of collection trucks into the tank cooler. This ramp also provides cover for the collection trucks, additional equipment and storage space for approximately sixty tons of dry feed used for supplementing purposes. The tank truck is driven under the ramp and spotted under the opening on the floor of the unloading platform above. A metal or canvas sleeve is run down from the opening above into the opening on the tank cooker below. There is no spillage of food material, and hosings from

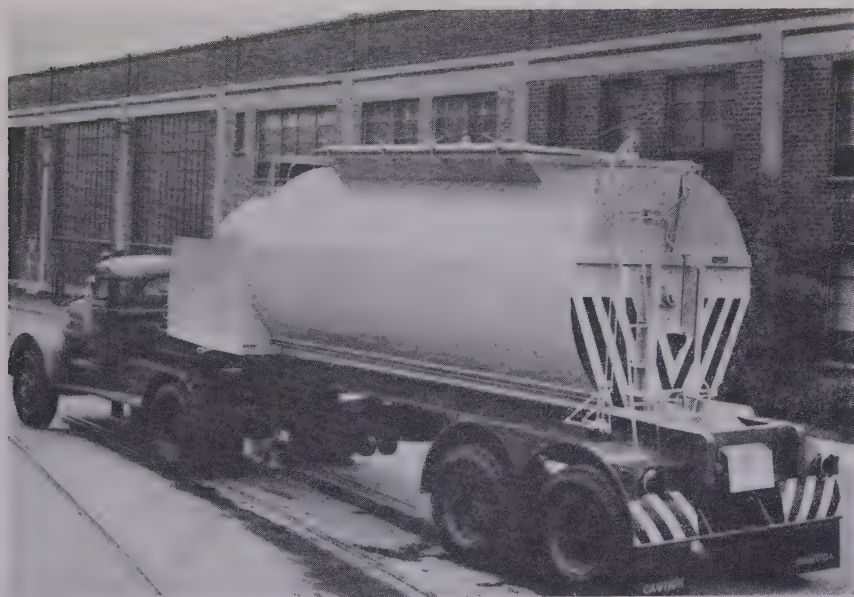


Figure 3. Large agitator tank truck

the floor above are washed into the tank as soon as the collecting truck has dumped its load. This procedure greatly reduces the fly nuisance. The tank cooker when full is driven to the cooking platform.

The food waste is agitated at intervals during the cooking operation. Agitation while loading or prior to cooking is also indicated in order to reduce excessive strain on the agitator shaft and power "take-off." Agitation at 15 minute intervals, reversing the motion each time, is sufficient during the cooking period. In one hour the entire mass will reach a boiling temperature throughout the load. Temperatures recorded after the shut down will run from boiling to 218 degrees F.

One man can conduct this cooking operation and do a thorough job of cooking in approximately one hour. This method also results in considerable savings in time, labor and fuel costs over other methods of truck cooking.

Larger and improved tank cookers now being built feature hydraulic lifts for the lids and outlet gate, easily controlled by the turn of a valve. Electric or auxiliary gas engines are installed on semi-trailer types for power to drive the agitator. Recording thermometers and other safety equipment to meet traffic and safety codes are also installed.

**Multiple Tank Installation.** A few large operators have installed two or more vertical tanks which remain stationary against a concrete bunker. They are from six to ten feet in diameter and depth, generally holding from 10 to 15 tons of garbage. Collection trucks drive in above and dump their garbage loads into the tank. Tank loads are stirred during the cooking period by metal paddles, attached to a central motor

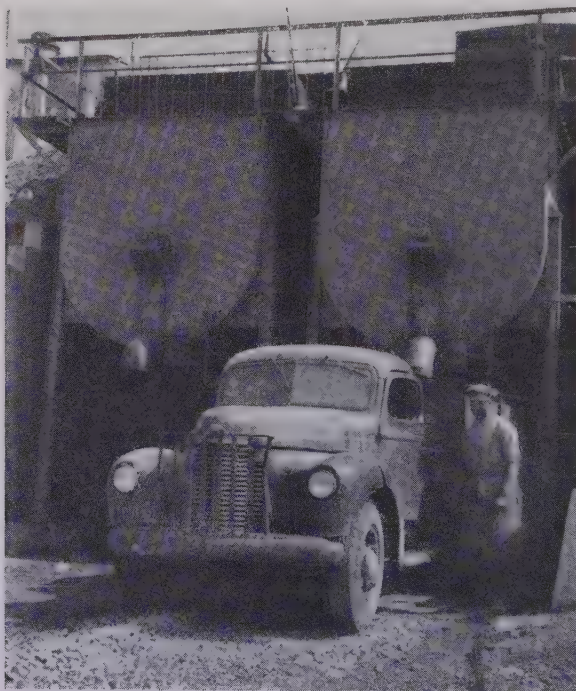


Figure 4. Multiple cooker shown here remains stationary, thus does not tie up collection trucks and personnel during cooking or feeding periods



Figure 5. Continuous flow steam cooker

driven shaft which revolves at 10 revolutions per minute. The lower part of the tank funnels down to a large outlet gate which discharges the cooked garbage into the feeding truck. This type of cooker does a dependable job of cooking in one to two hours. Its great advantages are that it does not tie up collection trucks and personnel during cooking or feeding periods, and it maintains throughout the load even cooking temperatures for one to two hours.

**Continuous Flow Steam Cooker.** This type of cooker, developed in the Monterey area, uses a large steel cylinder, approximately two feet in diameter and 30 feet in length, obtained from a sardine processing plant. The collection trucks dump raw garbage into a concrete pit located at one end of this cylinder. A screw type auger conveyor feeds the raw garbage into the end of the steam cylinder. Another large screw type auger moves the garbage through this 30-foot steam tube to the other end where the garbage is picked up by another screw type auger conveyor which discharges the cooked garbage into a feeding truck. Steam injection jets are intermittently located on the lower sides along the entire length of the tube. Pressure and temperature gauges are installed on the top side of the cylinder.

This is a continuous operation. Approximately 20 tons of garbage are cooked daily during a four- to five-hour period. It takes from 30 to 40 minutes for the raw garbage to pass through the cooking operation. The rate of movement through this operation can be controlled at all times. The garbage, which heats up very quickly after entering the steam cylinder, is under 15 to 20 pounds pressure in the middle sections and is thoroughly sterilized when discharged at temperatures ranging from 212 to 218 degrees F. Two steam-master boilers, 80 horsepower and 125 horsepower respectively, are installed; either is sufficient to do the job, but the extra is for standby purposes in case of breakdown.

The operators are well satisfied with the cooking job that can be accomplished with this equipment; however, it is too time-consuming for a daily operation. These operators intend to convert in the near future to a tank-agitator cooker which completes a cooking job in one to one and one-half hours.

**Supervision of Cooking.** Constant supervision is necessary to assure compliance with the requirements of the regulation for proper cooking of garbage for feeding to hogs. State, federal and county forces cooperate in this regulatory work. The field personnel conducting inspections at this time consists of three full-time state veterinarians, two full-time federal veterinarians, 40 part-time state and federal veterinarians, five full-time state lay inspectors and 10 full-time federal lay inspectors. A total of 60 persons therefore are engaged in inspection and direct supervision over hog ranches and other related activities under the state regulation and federal quarantine requirements.

Number of inspections and checks on garbage cooking temperatures depends upon the situation or condition at various premises. General policy requires a minimum of two inspections and one veterinary health inspection at each place each month. Efforts are concentrated on the larger operators of which there are about 200; these premises are inspected at least once a week. When an operator begins cooking garbage close supervision is maintained during the first 30-day period of approval. Often as many as 15 inspections are made during such a period.

Supervision includes not only checks on garbage cooking temperatures but also health inspections of hogs, quarantine of places when infection occurs, cleaning and disinfection of trucks, alleyways and pens, having persons who move from one hog ranch to another wash and disinfect their boots and equipment between places, requiring newly added hogs to be maintained in separate pens which have been cleaned and disinfected and the issuance of permits for shipment of fat hogs to slaughter.

The garbage feeding industry fulfills an economic need of metropolitan areas, since it diverts edible waste food products to useful purpose. Other methods possibly will be developed to treat food wastes and make them safe for swine feed, from the disease control standpoint. But at present the recommended method is cooking at proper temperature and required length of time.

## THE CHERRY FRUIT FLY IN NORTH AMERICA

### Morphological Differentiation Between the Eastern and Western Subspecies of the Cherry Fruit Fly, *Rhagoletis cingulata* (Loew)

By F. L. BLANC and H. H. KEIFER, California Department of Agriculture

Recent investigations by the writers have led to the discovery of morphological differences which definitely indicate the presence of two distinct geographical populations of the Cherry fruit fly, *Rhagoletis cingulata* (Loew). These studies were performed as a project assigned to the Office of Insect Identification in the California Bureau of Entomology.

#### HISTORICAL BACKGROUND

There are three species of fruit flies that are common pests of cultivated cherries. One species, *Rhagoletis cerasi* (Linn.), is the "Cherry fruit fly" of Europe. The other two species are native to North America. These are *Rhagoletis cingulata* (Loew), the Cherry fruit fly; and *Rhagoletis fausta* (Osten-Sacken), the Black cherry fruit fly. This paper deals only with *Rhagoletis cingulata* (Loew).

The original description of *cingulata* was in 1862, by H. Loew under the name *Trypeta cingulata*. The holotype is a female from "Middle States." In the same year Loew established the genus *Rhagoletis*, with *cerasi* as type, and included *cingulata* as a congeneric species.

Cultivated cherries in the Pacific Northwest have been attacked by "cingulata-like" cherry fruit flies since the early 1920's. It has generally been assumed that these flies were the result of an introduction from the *Rhagoletis cingulata* (Loew) population of the Eastern and Mid-western States.

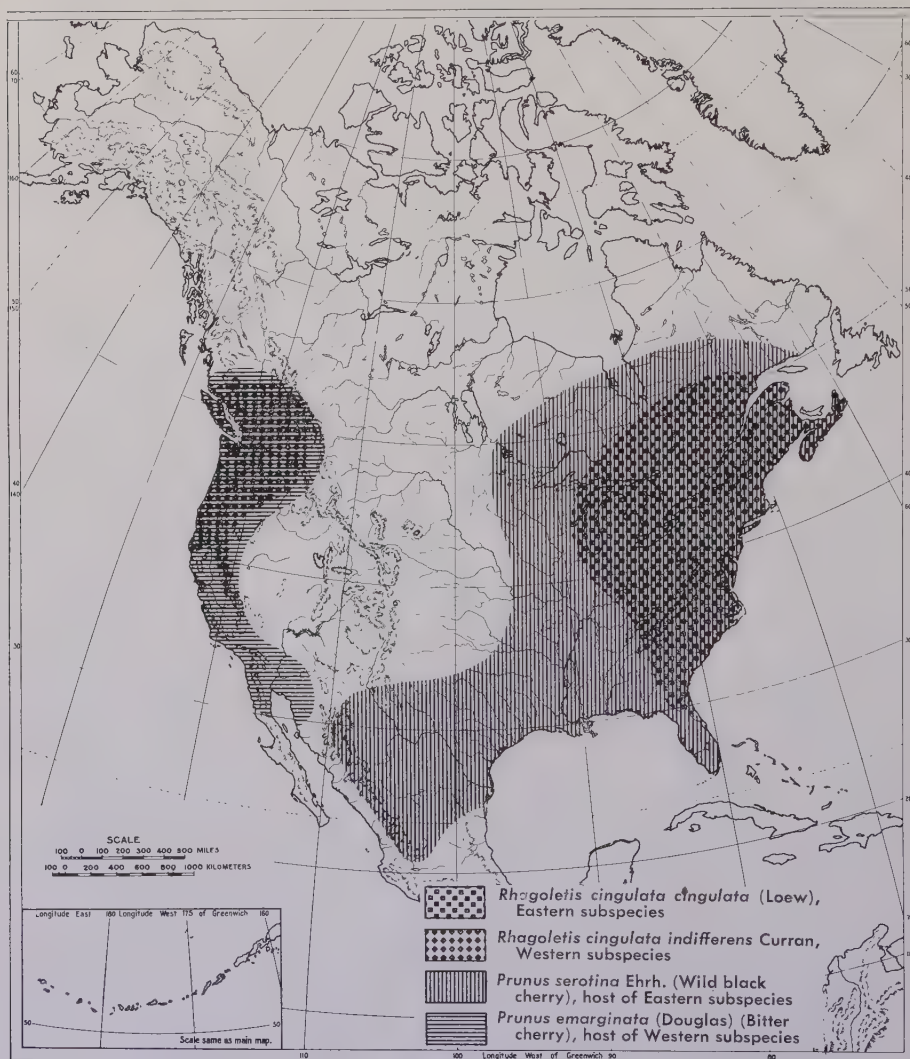
In 1930, S. C. Jones found "cingulata-like" flies infesting the native *Prunus emarginata* (Dougl.), Bitter cherry, in Oregon. Further investigation revealed the presence of these flies throughout much of the range of the Bitter cherry in the Northwest. Jones at first suspected the "Bitter cherry population" to be distinct from that in Oregon cultivated cherries. This premise seemed to be supported by the reluctance of the flies in some areas, infesting bitter cherry, to attack cultivated cherries even though the two hosts were immediately adjacent. As a result, Jones sent specimens of the "Bitter cherry fly population" to C. H. Curran for study. In 1932 Curran described them as a new species, *Rhagoletis indifferens* Curran, designating as holotype an adult taken from *Prunus emarginata*, at Hood River, Oregon.

Curran's description of *indifferens* was as follows: "Related to *cingulata* Loew from which it differs in characters of the male genitalia. While the genitalia show several differences, as may be determined by a comparison of the figures, the most obvious is to be found in the remarkably wide sustentacular apodeme in *indifferens* and this species is recognizable on this character alone."

F. H. Benjamin, in 1934, declared *Rhagoletis indifferens* Curran to be a synonym of *R. cingulata* (Loew), pointing out that the width of

the ejaculatory apodeme in the adult male of *cingulata* is extremely variable, even among individuals reared from a single host. (The present writers also found this to be true.) Since Benjamin's paper, there has been a variance of opinion among Dipterists as to the taxonomic status of the fly named by Curran as *indifferens*. Dipterists of the U. S. National Museum have, since 1934, continued to support Benjamin's view. V. T. Phillips (1946) maintained *indifferens* to be a valid species.

During 1942 and 1943, S. C. Jones (1943 and 1944) interbred representatives of the Oregon cultivated cherry fly with those from *Prunus emarginata* (Dougl.) in the same area, producing fertile offspring. He



North American distribution of *Rhagoletis cingulata* subspecies and their native hosts

Cherry Fruit Fly (Eastern sub-species), *Rhagoletis cingulata cingulata* (Loew).



also transferred maggots from one of these hosts to the other and obtained normal adults in all cases. He induced bitter cherry flies to oviposit in cultivated cherries, and vice versa. His conclusions (Jones, 1945b) were: "Investigations conducted in 1942 and 1943, show that there is no significant taxonomic difference between the cherry fruit flies infesting wild and cultivated cherries. Flies reared from *Prunus emarginata* will oviposit in cultivated cherries and complete their life cycle, and similarly those reared from cultivated cherries will oviposit and complete their life cycle in *Prunus emarginata*. Flies from either host will mate and reproduce."

H. G. Simkover (1953) crossed adults emerged from pupae collected beneath *Prunus emarginata* (Dougl.) at White Salmon, Washington, with adults emerged from pupae collected under Bing cherry trees at Prosser, Washington. The former location is immediately across the Columbia River from Hood River, Oregon, the type locality of *Rhagoletis indifferens* Curran. Prosser is in a district "—isolated from wild cherries." Apparently normal  $F_1$  generation adults were obtained from the cross, and this resultant second generation also interbred readily. Measurement of the width of the ejaculatory apodeme of the  $F_1$  males demonstrated that the size of this structure is highly variable. Simkover conducted experiments to demonstrate host preference of the adult female flies during oviposition. His results indicate that, when given a choice of either wild or cultivated cherries, the females preferred to oviposit in the cultivated fruit, regardless of the former host of the flies.  $F_1$  generation adult females resulting from interbreeding of cultivated cherry flies with wild cherry flies (as given above) also showed a preference for cultivated cherries for oviposition. Simkover concludes by challenging the validity of *Rhagoletis indifferens* Curran.

### A CHANGE IN CONCEPT

Prior to the present work it has generally been taken for granted that the "*cingulata*-like" flies infesting **cultivated cherries** in the Pacific Northwest were an introduction from the cultivated cherry-infesting population of the Eastern and Mid-western States. Phillips (1946, p. 65) gives the distribution of *R. cingulata* (Loew) as including: " \* \* \* the entire middle and eastern region of the United States and Canada, and also embraces the cherry region of the northwestern part of this country." Newcomer (1950, p. 31-32) in referring to *R. cingulata* (Loew) in cultivated cherries of Oregon, Washington, Idaho, and Montana, stated: "This insect is a native of the Eastern States."

Recent observations by the writers indicate that the fly population in cultivated cherries in the Pacific Northwest is distinct and morphologically separable from that of the Eastern United States and Midwest, and cannot be considered an introduction from the latter areas. These flies in western cultivated cherries are definitely allied to the flies attached to native bitter cherry, and, we believe, came from this western native fly population.

### SUBSPECIFIC STATUS

Based on the morphological data which follow in this paper, the authors believe the flies of the "*cingulata* complex" in North America are of two anatomically and geographically distinct population groups. We further believe that, with the information available at this time, these two warrant treatment as subspecies. We propose that the flies inhabiting the eastern United States be called *Rhagoletis cingulata cingulata* (Loew), and that the population of the Pacific Northwest, represented by Curran's type from Hood River, Oregon, be known as *Rhagoletis cingulata indifferens* Curran.

There is reason to suspect that the "*cingulata*-like" flies in certain mountainous areas of California may represent still another population group. Much further investigation and the securing of many specimens from intermediate areas is necessary in order to confirm or deny this supposition. We mention this only to save possible future taxonomic difficulties regarding the subspecies *indifferens* in case other population segregates are recognized on the Pacific Coast.

### ANATOMICAL SEPARATION

The eastern and western subspecies may be separated either in the adult or third instar larval stage. The latter exhibits the more striking and constant difference.

#### Larva (3rd instar)

1. **Thoracic spiracle:** The range in the number of "papillae" present on the thoracic spiracles is decidedly different in the eastern and western populations. Counts by the writers of a large series of specimens from Michigan and another large series from Pennsylvania revealed a range for the eastern subspecies of 21 to 31 papillae per spiracle. Examination of hundreds of larvae of the western subspecies, from both cultivated cherry and from the native "Bitter cherry," *Prunus emarginata* (Dougl.), from British Columbia, Idaho, Washington, Oregon, and California, revealed a range of 7 to 19 papillae. So far, the authors have not observed any overlapping of the ranges.

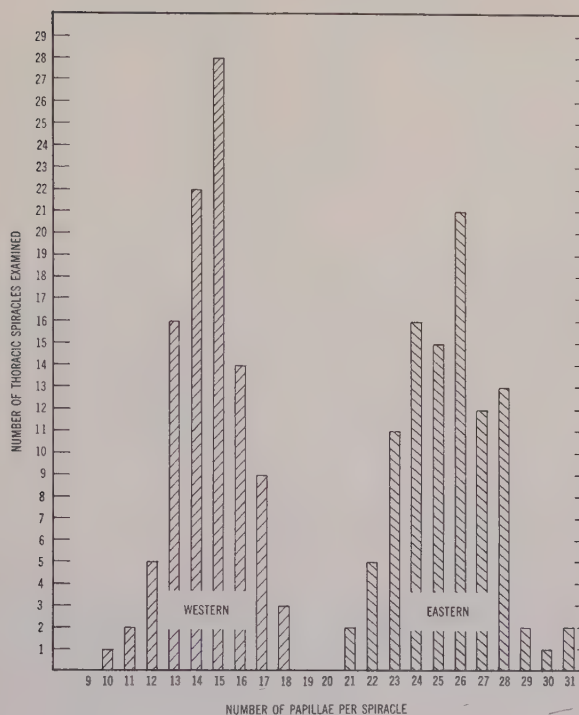


Chart No. 1

Number of papillae on thoracic spiracles of larvae

The accompanying illustration (Chart No. 1) represents graphically the number of papillae on the thoracic spiracles of the eastern and western subspecies. Note that this graph does not include papillae counts on maggots in *Prunus emarginata* (Dougl.). The thoracic spiracular papillae on larvae available to us from this host in Oregon ranged in number from 12 to 19, the same as the range in Oregon cultivated cherries. Larvae taken from *Prunus emarginata* (Dougl.) at Dutch Flat, California, exhibited a range of 7 to 15 papillae.

In the particular samples represented in the graph (Chart No. 1), the eastern population counts were made from 50 samples from Michigan, combined with 50 samples from North East, Pennsylvania. Both were from cultivated cherries. The western population is represented by a composite of 100 samples, composed of 10 (samples) from each of the following localities: Lewiston, Idaho; Coeur d'Alene, Idaho; Spokane, Washington; Bremerton, Washington; Centralia, Washington; Delake, Oregon; Portland, Oregon; Eugene, Oregon; Ashland, Oregon; and Hamburg in the extreme northern part of California. All of these western samples were from cultivated cherries, and were selected from all the material available to the writers in order to represent as large an area as possible in the Pacific Slope population attacking cultivated cherries. Other than geographical origin, these samples were selected without prejudice. The accompanying map (Chart No. 2) of the western portion of the United States illustrates the sample distribution.

In addition to a difference in the number of papillae, the thoracic spiracles exhibit a geographical difference in the tendency to develop more than one row of papillae. Subspecies *cingulata* of the East always possesses at least two rows (Figs. E-3 and E-4). Subspecies *indifferens* of the West very often has but a single, simple row (Figs. W-4 and W-5), although many individuals have a partial second row (Fig. W-3).

Phillips (1946, PL. VI, Fig. 67) illustrated the thoracic spiracle of *R. cingulata* from New York material, as having only 19 papillae, and

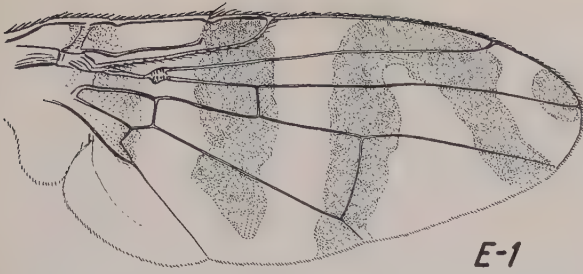


Chart No. 2.  
Map showing origin  
of western  
specimens used in  
Chart No. 1

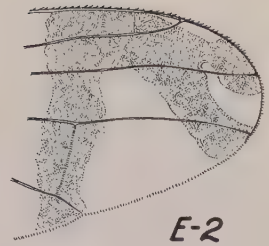
these in a single row. We have not observed as few as 19 papillae in eastern specimens available to us, and believe that a second row of papillae may have been inadvertently omitted from the illustration. Phillips pictured the spiracle of the western subspecies (PL. VII, Fig. 69), taken from *Prunus emarginata* (Dougl.) at Corvallis, Oregon, as having 13 papillae, and with these in a single row. This agrees with our observations.

2. **Posterior spiracular slits:** The ratio of length to width of the "slits" or openings of the posterior spiracles is greater in subspecies *cingulata* than in *indifferens*. However, there is an overlapping in the ranges of variation of the two populations. In individuals examined by the authors, the eastern form averaged 4.2 : 1; the western form averaged 3.5 : 1. Both the eastern and western samples in this case were from cultivated cherries. The measurements were made on slide-mounted specimens by the use of a compound microscope and a micrometer disk. Each slit measurement includes the over-all distance to the outside edge of the sclerotized spiracular plate.

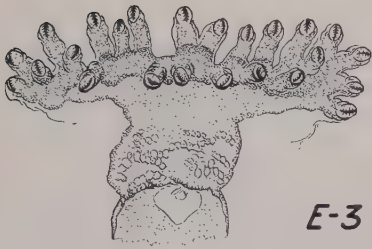
The length-width ratios of the posterior spiracular slits in larvae collected in *Prunus emarginata* (Dougl.) at Dutch Flat, in the Sierra Nevada Mountains in east-central California, averaged only 2.8 : 1. We mention this because it may indicate a morphological divergence of the flies in the Sierra Nevadas of Central California from those of areas farther north.



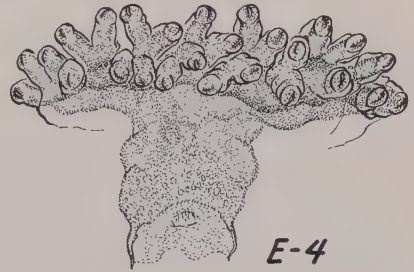
E-1



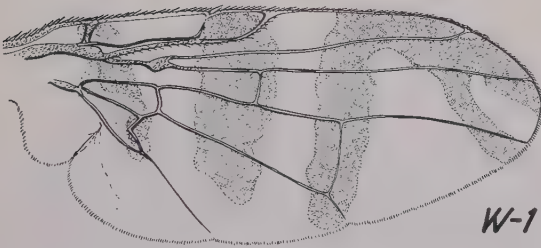
E-2



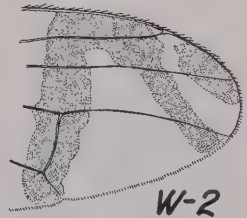
E-3



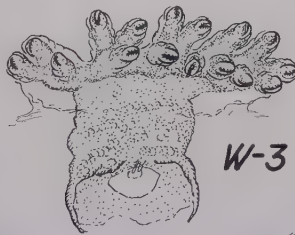
E-4



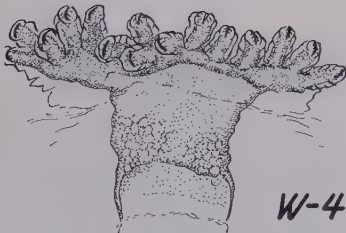
W-1



W-2



W-3



W-4



W-5

PLATE No. 1

Figures E-1 (typical), E-2 (atypical), wings of eastern flies

Figures E-3, E-4, thoracic spiracles on eastern maggots

Figures W-1 (typical), W-2 (atypical), wings of western flies

Figures W-3, W-4, W-5, thoracic spiracles on western maggots

The tubercles surrounding the posterior spiracles show differences of value in separating certain species of *Rhagoletis*. However, these tubercles have not proved to be helpful in the present case. Both P. C. Ting, who preceded us in this study, and the writers, have been unable to use these tubercles for population separation within the species *cingulata* (Loew).

### Adult

Anatomical and color differences between the adults of the two subspecies were, so far as found, not as striking nor decisive as those mentioned above for the last larval stage. However, they do support the evidence of divergence exhibited in the larvae. Undoubtedly future studies of these flies will reveal additional definitive characters.

1. **Fuscous wing markings:** Considering the *Rhagoletis cingulata* complex of North America all together, two different patterns are present on the wings. In the first type, the distal extension of the apical costal band is separate, leaving an isolated spot astride the third vein where the latter joins the costa. (Fig. E-1). In the second type, the distal extension of the apical costal band is contiguous with the penultimate branch, forming a costal arm which terminates slightly beyond the junction of the third vein and the costa. (Fig. W-1). The vast majority of specimens of the eastern subspecies have the first, or "terminal spot" type. (Fig. E-1). The remaining small percentage of this group have the "forked" type. (Fig. E-2). In the western subspecies, by far the most common is the second, or "forked" pattern (Fig. W-1); while but a few exceptions possess the "terminal spot" design. (Fig. W-2). It is interesting to note that published illustrations of the Cherry fruit fly which deal solely with the population in the eastern or midwestern areas of the continent usually show the "terminal spot" type of pattern, while those dealing solely with the Pacific Coast population show specimens with the "forked" pattern. One exception to this is the revisional work by Cresson (1928) in which he illustrates *cingulata* with the "forked" design. However, in his verbal description of the species (p. 408) he states: "It is easily distinguished by the apparent bending of the apical costal band leaving a spot of brown at the tip of the third vein."

2. **Apical marking of abdominal tergites:** In general there is a much greater degree of "white banding" of the abdominal tergites in subspecies *cingulata* than in *indifferens*. The number of tergites having bands, as well as the width of the bands, varies so greatly between individuals in a given series, in either of the subspecies, that it is necessary to designate a body location that is always white-banded in the eastern form, but is always void of the white band in the western form. In specimens available to the authors, we find that all of the males of the subspecies *cingulata* have an apical white band on the prepygidial tergite, while the corresponding tergite of the *indifferens* males lacks the white band. We found that both sexes of the subspecies *cingulata* very often had white bands across the basal portion of several abdominal tergites, in addition to the apical bands. These were often hidden by the overlapping of the tergites.

3. **Coloration of anterior coxae:** As in the above case of the tergal banding, the magnitude of fuscous marking on the legs varies markedly.

In general, the western form has a greater amount and intensity than the eastern. In specimens of both sexes which we examined, the anterior coxae of subspecies *indifferens* always showed some degree of fuscous marking; although that of a few individuals was very slight. The anterior coxae of all our specimens of subspecies *cingulata* are entirely yellow or straw-colored.

4. **Length-width ratio of ovipositor:** On specimens of adult females examined, the eastern subspecies exhibited a wider ovipositor, in relation to length, than did the western subspecies. Length measurements were taken from the distal tip to the anterior extremity of the sclerotized dorsal process. The length-width ratio for a group of specimens from cultivated cherries from Michigan ranged from 5.2 : 1 to 6.7 : 1, with an average of 5.6 : 1. The ratio for a group of specimens on cultivated cherries in Oregon ranged from 7.2 : 1 to 8.1 : 1, with an average of 7.5 : 1.

#### KEYS TO THE SUBSPECIES

The following keys are given in order to facilitate the separation of adults or third instar larvae of the two subspecies.

#### Adults

- 1A. Forecoxae straw-colored; male with prepygidial tergite having a white apical band; ovipositor with length-width ratio below 7 : 1; wing with fuscous pattern usually having an apical spot astride the extremity of the third vein (occasionally with distal fuscous branch contiguous with penultimate branch, forming a fork); habitat: Eastern and Mid-western United States and adjacent areas of Canada; hosts: *Prunus serotina* Ehrh. and cultivated varieties of *Prunus avium* L. and *Prunus cerasus* L. ----- *Rhagoletis cingulata cingulata* (Loew)
- 1B. Forecoxae with some degree of fuscous marking, at least at base; male with prepygidial tergite lacking white apical band; ovipositor with length-width ratio over 7 : 1; wing with fuscous pattern nearly always having the distal extension of the apical costal band contiguous with the penultimate branch, forming a fork (rarely with an apical spot); habitat: British Columbia, Idaho, Washington, Oregon and mountains of Northern California; hosts: *Prunus emarginata* (Dougl.) and cultivated varieties of *Prunus avium* L. and *Prunus cerasus* L. ----- *Rhagoletis cingulata indifferens* Curran

#### Larvae (3rd instar)

- 2A. Number of papillae on anterior spiracles between 21 and 31  
----- *Rhagoletis cingulata cingulata* (Loew)
- 2B. Number of papillae on anterior spiracles between 7 and 19  
----- *Rhagoletis cingulata indifferens* Curran

#### TAXONOMIC EVALUATION OF DIFFERENCES

Based upon the evidence given above, the writers believe the eastern and western populations are morphologically distinct from each other. Judging by all available collection records, these two populations are allopatric (geographically separated). We have no present means of determining whether or not they are reproductively isolated. By application of the "discrimination grid" as set forth in Mayr, Linsley, and Usinger (1953, p. 79) we may conclude that the two populations are either different subspecies or different species, depending upon whether or not they are reproductively isolated. We have taken the more cautious choice, treating them as subspecies. Future interbreeding experiments may definitely prove or disprove this premise.

Concerning the possible occurrence of more than one "race" or "strain" of the "*cingulata* complex" in the Pacific Coast States and

British Columbia, we have, in the present study, approached the problem only from the morphological aspect. Much additional information is needed to properly relate our observations to the actual population groups in the field. It is our hope that our findings will stimulate further research by other workers toward a more complete understanding of these flies.

#### ACKNOWLEDGMENTS

The writers are indebted to P. C. Ting, formerly of this Bureau, who preceded us in this work and who discovered the morphological characters which allow easy separation of the larvae of *Rhagoletis fausta* (Osten-Sacken) from the larvae of *R. cingulata* (Loew). This information is highly important since the two species have almost identical hosts and geographical ranges.

We gratefully acknowledge the effort and kindness of those in other states who gave of their time and energy to secure and send us specimens: S. C. Jones of Oregon State College; J. A. Cox of Pennsylvania State College; and D. A. Lovett of the Michigan State Department of Agriculture.

We express our thanks also to E. G. Linsley and R. L. Usinger of the University of California for suggestions and counsel.

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## CURRENT INSECT NOTES

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Since the last report on the Khapra beetle, *Trogoderma granarium*, the area of infestation has been extended north in the Sacramento Valley to Glenn County, with three infested premises reported in that county. At the same time two infestations have been reported in Alameda County, making three to date in the San Francisco Bay region. Centers of infestation remain in Imperial, Kern and Fresno Counties to which group Colusa County has recently been added.

Follow-up of shipments moving out of infested storage in Colusa County, before its presence there was known, added Alameda, Glenn, Lake, Butte and Sutter Counties while recording 15 new properties in Colusa County. Indications are that most of this spread has been very recent and involves primarily farm holdings for direct feeding or planting.

Since January 1 the number of infested premises has increased to 121 in 16 counties. This number results from 17,000 hours inspection of over 4,000 premises by federal, state and county personnel. The infested premises represent only about 3 percent of the total inspected, indicating relatively restricted distribution. Of this total, nine premises have been treated and released from infested status, seven in Imperial County and one each in Los Angeles and Tulare Counties. Others are scheduled for early fumigation.

New infestations as found are about equally associated with barley and with bags used in handling of grains and make up most of the findings. Other hosts include wheat, rice, vetch seed and processed grain. Berseem clover seed, *Trifolium alexandrinum*, has been recorded as a host for the first time.

A new species of mealy bug *Spilococcus* n. sp. was submitted by G. W. Schwegel, San Diego County Agricultural Inspector from National City, where it was found infesting *Euonymus* var. This first collection was made on December 21, 1954. Infestation was reported heavy with typical mealy bug damage to the host in the form of excessive honeydew and associated disfiguring sooty mold fungus. This same species was again submitted from Chula Vista where heavy infestation was found on carnation by G. Buxton, San Diego County Agricultural Inspector. Local measures are being taken to reduce infestation under supervision of the county agricultural commissioner's office, until more adequate survey can be completed and any pest importance more adequately determined.

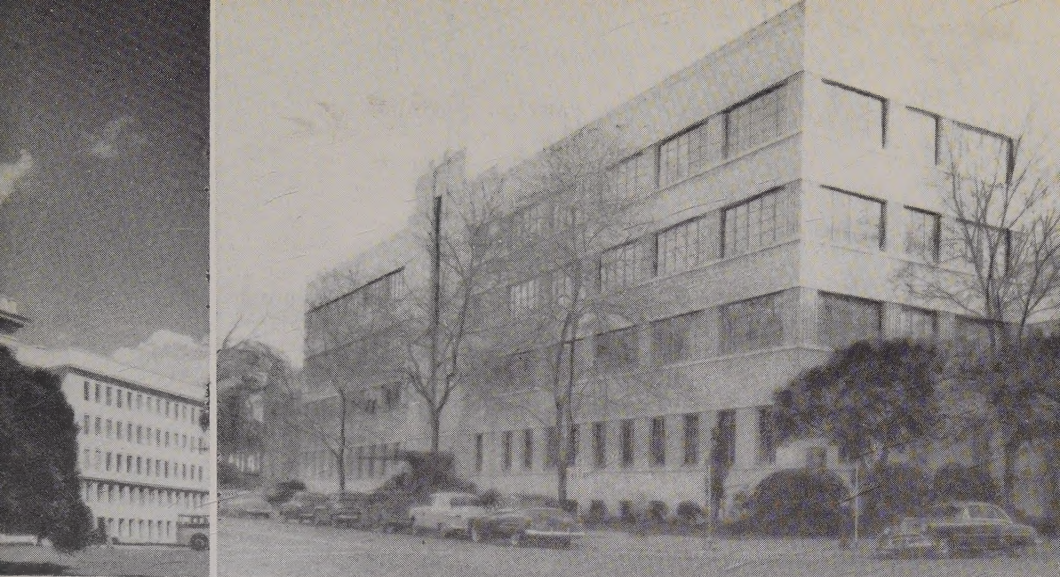
The yellow clover aphid (*Therioaphis ononidis*) was first reported in California from San Diego County on February 7, 1954, when it was found infesting burr clover (*Medicago hispida*) in the City of San Diego, and later as widespread in Imperial and Riverside Counties on alfalfa. Subsequently, as previously reported, single infestations were

reported at Newberry, San Bernardino County, Santa Ana in Orange County, and at Lancaster in the Antelope Valley, Los Angeles County. All of these later reports showed alfalfa (*Medicago sativa*) as the host. On February 8, 1955, H. E. Bronson, Ventura County Agricultural Inspector, submitted specimens taken on alfalfa at Santa Susana, Ventura County, for the first time in that county. On February 8, 1955, Guy Beevor, State Survey Entomologist, picked up a single specimen on alfalfa at Edison, Kern County, for a first record for that county. The rapidity of natural spread northward within the State is both unbelievable and alarming.

New Mexico reported serious losses from this new western aphid in 1953. Imperial and Riverside similarly reported hundreds of thousands of dollars in loss of crops and cost of control during 1954. Infestation destroys new plantings making extensive replanting of large areas necessary. It kills out larger plants working from the lower leaves out to the tips. Unusually heavy honeydew interferes seriously with harvesting and the associated sooty mold fungus down-grades the hay. It would appear that application of an insecticide such as parathion may be required for each cutting if effective control is to be maintained. It is not yet certain that the species is the same as that common to wild clover in the mid-western states, which has not previously included alfalfa among its hosts, or whether it may represent the form found in India which seems restricted to that host. The taxonomy is under study by department entomologists.

It is with considerable regret that it becomes necessary to report the finding of Hall scale (*Nilotaspis halli*) on almonds grown as yard trees on a residential property in the City of Chico, Butte County. The infestation was found by members of the regular federal survey crew who were combing this area for the third time in recent years to uncover any such situations, if they existed. The finding further supports the known difficulty of finding such infestation by visual inspection before they have reached a certain density. In the meantime they may have been responsible for outward spread until it in turn has reached the same density. It is for this reason that when a new infestation is found every host tree within a radius of 2,500 feet or a half mile is brought within a treatment area in the application of eradication measures. This distance is, as a safety factor, twice the anticipated spread during the period apparently required to develop infestation to a point where it can be detected. The new finding is not entirely unexpected and merely extends the date when eradication of this important pest can be written off successfully.

Attention is called to the fact that recently the department has issued illustrated keys to the identification of the Khapra beetle and to that of lepidopterous larvae attacking nut crops. The first was prepared by Louis Blanc and George Okumura, bureau taxonomists, and the latter by George Okumura. Copies are available on request to the Bureau of Entomology.



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